Measuring the evolution and output of cross-disciplinary collaborations within the NCI Physical Sciences–Oncology Centers Network

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PHYSICAL SCIENCES in ONCOLOGY

ABSTRACT

This poster highlights an example of a **prospective evaluation** that has been developed to **monitor and improve progress of the National Cancer Institute Physical Sciences-Oncology Centers (PS-OC) Program**. Integration of novel and standard data sources was augmented by the development of automated methods to mine investigator pre-award publications, assign investigator disciplines, and distinguish cross-disciplinary publication content. The results highlight increases in cross-disciplinary authorship collaborations from pre- to post-award years among the primary investigators, identified barriers faced by cross-disciplinary research teams, as well as program-specific outcomes.

Physical Sciences – Oncology Center Program

Program Objectives:

- Generate **new knowledge** and catalyze **new fields of study** in cancer research by utilizing physical sciences/engineering principles
- Enable a better understanding of cancer and its behavior at **ALL** scales.
- Develop new perspectives and approaches to do **paradigm-shifting** science.
- Build **trans-disciplinary teams** and infrastructure to better understand and control cancer through the convergence of physical sciences and cancer biology.

Physical Sciences – Oncology Centers:

- Twelve Centers were funded by NCI in September 2009 through U54 mechanism.
- Each Center is composed of physical scientists and cancer biologists.

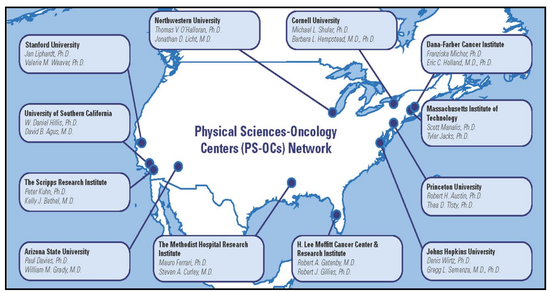

Figure 1. Location and leadership scheme of the twelve Physical Sciences – Oncology Centers (PS-OCs) funded by NCI. Each PS-OC has a principal investigator (PI) that is a physical scientist and a senior investigator (SI) that is a cancer biologist. Each PS-OC consists of three to five interactive Projects and a minimum of two collaborative Cores. Each PS-OC averages 10-12 investigators. The PS-OCs are located at Arizona State University, Cornell University, Dana-Farber Cancer Institute, H. Lee Moffitt Cancer Center, Johns Hopkins University, Massachusetts Institute of Technology, Northwestern University, Princeton University, The Methodist Hospital Research Institute, Stanford University, and University of Southern California.

METHODS

Study data, including collaboration information, were captured through progress reports and compiled using a custom web-based analytic database: Interdisciplinary Team Reporting, Analysis, and Query Resource (iTRAQR). Analysis of collaborations was further supported by data from the Thomson Reuters Web of Science database, MEDLINE database, and a web-based survey. The disciplines of all trainees and investigators within the PS-OC Program were determined based on progress reports, survey data, and development of an automated classification algorithm. Cross-disciplinary collaborations and outputs were analyzed both within centers and across the PS-OC Network.

RESULTS

Highlights:

- Increases in cross-disciplinary authorship collaborations from pre- to post-award years among the primary investigators (Figures 2-4, 6-7).
- The identified outcomes were the development of new knowledge or skills, presenting at conferences or invited talks, and producing publications. Many also indicated that they intend to pursue new aspects of the project as an extension of this work, or indicated that the collaboration is still in progress (Figure 9).

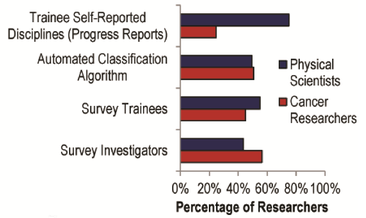

Figure 2. Investigator discipline assignment comparison via self-report (progress reports and survey) and automated classification algorithm.

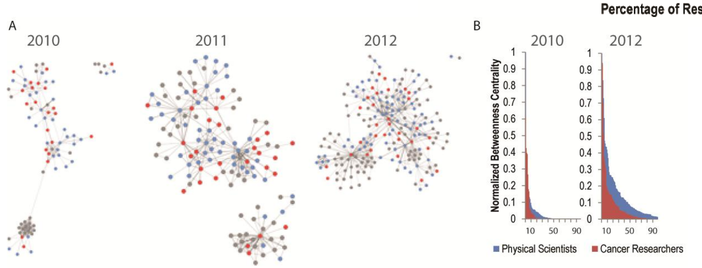

Figure 3. (A) Force-directed network graphs of reported collaborations generated using iTRAQR. Nodes represent a physical scientist (light gray), cancer researcher (dark gray), or unknown discipline, respectively. Edges represent all types of reported collaborations (non-publication, publication, project for within and outside the network) with the weight equal to the total number reported for that particular pair of researchers. (B) Normalized betweeness centrality value for the top 100 key nodes in the entire network diagrams for physical scientists and cancer researchers after 6 months (2010) and 3 years (2012). *For information on the bibliometrics used in this program evaluation, please poster # F-19.*

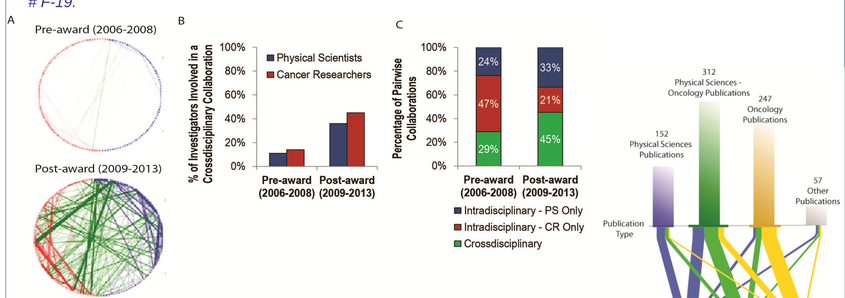

Figure 4. (A) Collaborations pre- and post-award. Each red dot represents one physical scientist and each blue dot represents one cancer biologist. The lines connecting investigators represent pair-wise collaborations, with green lines being cross-disciplinary in nature; (B) Percentage of PS-OC Investigators involved in a cross-disciplinary collaboration, by discipline pre- and post-award; (C) Percentage of pairwise intra and cross-disciplinary collaborations.

Figure 5. Flow diagram showing the correlation of type of authorship collaborations (cross-disciplinary (PS–CR), intra-disciplinary physical scientists (PS–PS) or intra-disciplinary cancer researchers (CR–CR) with the analysis of publication content (physical sciences–oncology, physical sciences, or oncology). Thickness of the lines reflects the percentage or investigators or publications contributing from one category to the next.

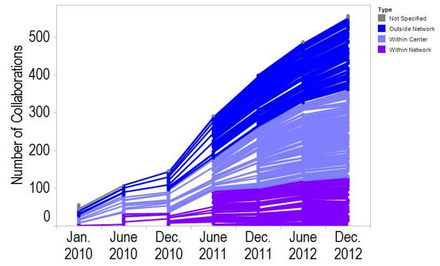

Figure 6. A summary of the continuity of collaborations reported by investigators in the progress reports every 6 months. Each line represents continuity of the same collaboration across two progress report periods.

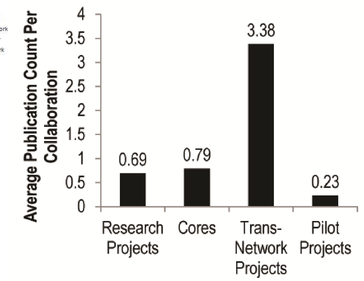

Figure 7. Publications per pairwise collaboration type within the PS-OC Program. The research projects (41 projects) and cores (22 cores) produce on average less than one publication per reporting period. Trans-network projects (20 projects) have a higher publication output per collaboration.

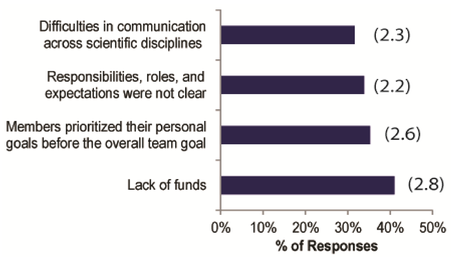

Figure 8. From the survey, respondents indicated the barriers they faced and ranked the level of severity of each item (Scale: 1–5, 5 is most severe).

Figure 9. Collaboration Outputs as selected by investigator survey respondents as a heat map, with more prevalent outputs in red, orange, and yellow, and less prevalent outputs in green and blue. For more information about the survey, please see the poster entitled, "Prospective Evaluation of the National Cancer Institute's Physical Sciences-Oncology Centers Program."

	Physical Scientists	Cancer Researchers
New knowledge or skills	89%	77%
Collaboration is still in progress	81%	86%
Publications	70%	49%
Presentations or invited talks	70%	37%
Pursue new aspects of the project as an extension of this work	59%	49%
Trans-Network project funds	37%	20%
Will form new collaborations	33%	37%
Pilot project funds	33%	17%
NIH or NSF grant funds	15%	9%
Outreach project funds	15%	6%

CONCLUSION

- Comprehensive data sources, analysis methods, and iTRAQR-like information systems enable prospective grants program monitoring and evaluation.
- Tracking progress in near real-time while developing new metrics in line with program goals provides program officials and investigators with ongoing feedback.
- Incorporation of researcher discipline information into the network analysis provides novel measures focused specifically on understanding and improving cross-disciplinary collaborations, and new insights into generating mechanisms of collaborations, such as an increased emphasis on trans-network projects, and has led to new strategic directions to increase collaborations and productivity by investigators.

For journal article: doi:10.1093/reseval/rvt025

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